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THE
PHILOSOPHY
OF
EARTHQUAKES,
NATURAL and RELIGIOUS.
OR
An Inquiry into their Cause, and their
Purpose.

*O Vitæ philosophia dux, virtutum indagatrix, expultrixque
vitii!* Cicero.

By WILLIAM STUKELEY, M. D. Rector
of St. George's, Queen-Square: Fellow of the
College of Physicians and Royal Society:

The SECOND EDITION.

To which is added, PART II. on the same Subject.

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To the READER.

TH E substance of the philosophical part of this discourse was delivered at twice to the Royal Society, on March 15, and 22: The theological, in my own church. I could not refuse the solicitation of my friends, bearers in both places, to print it. I wish my intention, in the compliance, may any ways prove successful; to show, how vain, and unmeaning, are all our philosophical inquiries, when destitute of their true view; to lead us into the more engaging paths of religion. That, from speculation of material causes, we may become adepts in that wisdom which is from above. Otherwise, like Epicurus, and the ancient beaten philosophers, we barter away our immortal part, for a curiosity, that amuses us to no good purpose. Mean are these objects of our senses to be accounted, in comparison of our spiritual

To the READER.

natures, to which our principal regard is due! For we must rightly say with Job: Lo, these are parts of God's ways, but how little a portion is heard of him? and the thunder of his power, who can understand?



To

T O

Martin Folkes, Esq; LL.D.

President of the Royal Society.

March 26, 1750.

WHEN so great and unusual a *phænomenon*, as an earthquake, and that repeated, happens among us ; it will naturally excite a serious reflexion in every one that is capable of thinking. And we cannot help considering it, both in a philosophical, and a religious view. Any mind will take the alarm, when we perceive a motion that affects the earth, that bears the whole city of *London*, and some miles round it. And at the same time while it gives us so sensible a shake, so gently sets us down again ; without damage to any buildings, and without a life lost.

'Tis hard to say, which is the greater wonder. But alas in the works of nature, there are no degrees of great, and little ; comparisons are incompatible. We indeed are more affected with what seems great in our own apprehensions : I would rather say, what is rare and

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unusual.

unusual. An omnipotent power admits of no distinctions. And when prodigious effects are produc'd from causes imperceptible, it rightly claims our most serious attention, as well as wonder. Nor need we lose sight of the theological purpose of these amazing alarms; whilst we endeavour to find out the philosophy of them.

Among all the appearances of nature, which are the subject of the inquiries of the Royal Society, none more deserves the regard of a contemplative mind. And among the very numerous accounts received there, from all quarters, being only Observations upon the manner of it, and its extent: I judg'd, it became us to inquire into the *cause* of so extraordinary a motion: of which we could not form a proper idea; had we not repeatedly seen, and felt it.

The moderns have not improv'd upon the opinions of the ancients, in this matter; any further than by the fancied analogy of some chymical experiments. But these chymical experiments, and all sorts of explosions by gunpowder, and the like, are to me a very unsatisfactory solution; they are merely artificial compositions, which can have nothing similar in the bowels of the earth, and they produce their effects by violence, by rending and tearing, by a *solutio continui*. This is indeed too often the case of earthquakes, but *that* in a partial

partial degree, not at all equivalent to the compass of the shock ; and is very far from being the constant concomitant of an earthquake. Quite the contrary. Innumerable such happen, when there is no breach of the surface ; and of these three or four which we have now felt, nothing of it has appear'd. But the immensity of the vibration of the earth which shook every house in *London*, with impunity, and for twenty miles round, can never, in my apprehension, be owing to so unbridled a cause, as any subterraneous vapours, fermentations, rarefactions, and the like ; the vulgar solution. Nor does the kind of motion, which I discern in an earthquake, in any sort agree with what we should expect from explosions.

In order then to proceed with some degree of certainty, in our inquiry after the cause of earthquakes, it will be useful, in the first place, to set in one view, the general appearances remarkable therein ; the most usual concomitants : As we can collect them from our own observation, or from the relations and writings of others.

CIRCUMSTANCES.

I. That earthquakes always happen in calm seasons, in warm, dry, sultry weather ; or after a dry, frosty air.

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II. That

II. That they are felt at sea, as well as land, even in the main ocean; and at that time, the sea is calm.

III. That earthquakes differ very much in magnitude. Some shake a very large tract of country, at the same instant of time; nay, sometime extend to very many countries, separated by mountains, seas, lakes, the ocean.

IV. That earthquakes differ very much in the quantity, of their vibratory motion: Whence in some, tho' largely extended, they are innocuous; in others, both small and great, they lay all in ruin and destruction.

V. That a hollow, thundering, unusual noise accompanies them, or rather seems to precede the shock; which rolls in the air like the noise of cannon.

VI. That they are felt more sensibly in the upper story of houses than in the lower.

VII. That the shock is more violent upon more solid buildings, churches, castles, and stone-houses, than upon those of slighter materials.

VIII. That many people find themselves sick at stomach, with headake, and pains in their joints, and the like, which sometime lasts for the day after, or longer.

IX. That earthquakes generally happen to great towns, and cities, and more particularly to those that are situate on the sea.

X. That earthquakes do not cause any damage

image to springs and fountains ; but the water in wells becomes foul for a short time.

XI. That they are more frequent in the neighbouring countries of a volcano.

This last circumstance, in my opinion, has led all inquirers in this question, out of the true path ; therefore I propose in the ensuing paper.

I. To shew what it is not ; the insufficiency of the vulgar opinion, of subterraneous fires and vapours.

II. To show what it is in reality, as it appears to me.

III. I shall conclude with the moral use we ought to make of these prodigies of nature.

I. The struggles of subterraneous winds and fires, that should heave up the ground like animal convulsions, seem to me impossible : Their powers, and manner of acting (if such there be) is quite incapable of producing the appearance of an earthquake. That these should operate instantaneously, in one minute, thro' a circle of 30 or 40 miles diameter, or more, I could not conceive. Nor that there should be any possible, much less ready passage thro' the solid earth, for such nimble agents, as every one is apt to imagine, that speak of this appearance ; without sufficiently reflecting on the insuperable difficulties in that *hypothesis*.

We cannot pretend to deny, that there may be such vapours, and fermentations, inflammable

ble substances, and actual fires, in the bowels of the earth ; and that there may be some caverns under ground, as well as we find some few above ground : such as *Pool's-Hole*, *The Devil's-Arse in the Peak of Derbyshire*, and *Okey-Hole in Somersetshire*. These, I believe, to have been so from the creation, never were made by earthquakes. We know, there are hot springs running continually : There are some volcano's frequently belching out flames and smoke, and to these perhaps some earthquakes may be owing, tho' not according to the vulgar notion ; as we shall see, by and by.

But these matters are very rare, much rarer than earthquakes, both as to time and place. *Vesuvius* in *Italy*, and in that part of it abounding with mines of sulphur : *Ætna* in *Sicily*, and *Heckla* in *Iceland* ; these are all we know of, in the old world. In the *Andes* mountains of *America* there are some. The scarcity of these appears to me a strong argument against the common deductions made therefrom, as to their being the cause of earthquakes.

Nor can I enter into the sentiments of those that hold the cavernous state of the earth, so as to contribute to the forming an earthquake by vapours running from place to place under ground. How many thousand acres of coal-mines do they daily work in *England*, and have done for ages ? I have been myself 2 or 300 feet deep in a solid rock of native salt : I have walked a mile lengthwise directly into the earth, and descending

descending all the way, in the proportion of one yard in five, 'till we came under the bed of the very ocean, where ships were sailing over our heads. This was at Sir *James Lowther's* coal-pit, at *Whitehaven*. We were at this time deeper under ground by the perpendicular, than any part of the ocean, between *England* and *Ireland*.

We never hear, from the many hundreds of thousands of workmen in this kind, at *Newcastle*, *Nottinghamshire*, *Yorkshire*, *Derbyshire*, *Staffordshire*, *Somersetshire*, and *Wales*: from the infinite numbers of workmen in the mines of lead, tin, and the like, of the cavernous state of the earth, so as to give any colour for this *hypothesis* of earthquakes. The earth is generally of solid rock; in which there must be now, and then, some clefts, and vacuities, small in compass, as naturally so many heterogeneous *strata* of the earth consolidate together. But there can be no imagination of vapours breaking through, uniting, traversing so suddenly, a large space of earth, so as to produce those earthquakes, we have seen, and felt; much less such as we read of. The workmen in all sorts of mines confess by their hard labour, that the earth is not cavernous; nor are there mines of sulphur, nitre, and the like inflammable materials in *England*. Or if there were, could they burn, and cause convulsions of the earth, without proper cavities, pipes, and conveyances of air;

air ; as vulcano's, and coal-pits, when set on fire. But even from these coal-pits, when fired, do we ever find any thing like an earthquake produced. Nor do we find earthquakes frequent in those countries, that abound with coal-mines, as certainly would be the case, if that *hypothesis* was just. How easy would it be, on the slightest occasion for earthquakes to happen in the countries abounding with coal-mines, which are so full of artificial cavities communicating with one another, for many miles together : The very thing supposed, by those who hold the old opinion, of vapours traversing the earth for that purpose.

In the coal-pits, some small natural cavities now and then are found ; which when opened, send forth a pestiferous vapour, and a fire-damp which runs for a long time together. And tho' there are many substances that may generate air, within the bowels of the earth ; yet these matters are infinitely unable to produce an earthquake : Never would have force to open a passage for themselves thro' the solid rock, of perhaps many hundred feet in thickness. Nor did we observe in these last earthquakes any fire, vapour, smoke, or smell, any kind of eruption, in the least ; as must certainly have been, in so great a struggle of the surface, as affected a circle of so large a diameter. Were there such, we could scarce hope any otherwise, than that they would be too

too sensibly felt ; to the destruction of many thousands, by their pestiferous qualities.

Indeed this consideration alone, of the extent of that surface, is sufficient to overthrow any supposition, of earthquakes being chiefly owing to subterraneous vapours : They cannot momentarily fly under so large a tract of ground, if they were near the outward shell of the earth. They could not do it without breaking ground, and discovering themselves to the sight, or smell; and that for a long time after. It cannot possibly be imagin'd, they should have so immense a force, as to lift up the city of *London*, and never be perceived by our organs, and outward senses. We have frequent accounts of a little fire-ball bursting in the air, at a distance ; yet it instantly propagates a sulphureous smell around.

If the movement of a superficies of 30 miles diameter was owing to fumes, and vapours ; we ought reasonably to find some great discharges of them, belching out smoke and fire, for a long time after, like vulcano's, and coal-pits fir'd. The operation of the shock ought to be of hours continuance, not instantaneous ; and the evaporation of so vast a quantity of matter, must darken the whole region of the air for a long time after ; or require a long time, if gradually it discharges itself. We see how immense a volume of smoke is produc'd
by

by a very small quantity of gun-powder ; and no vapour could be so subtle, that produc'd such effects, and not be very obvious to our senses.

Even in vulcano's, it is the opinion of the learned *Italian* philosopher *Borelli*, and of other great naturalists, that they are kindled first from the surface, where there is a possibility of ventilation from the air. They imagine, it begins at the top of the mountains ; not by any fancied fermentation of the *pyrites* and sulphureous vapours arising from subterraneous caverns, in the lower parts of mountains.

There is another consideration, which utterly overthrows these suppositions, of earthquakes being caused by any thing under-ground ; and that is a due consideration of springs, and fountains perpetually flowing ; and that from the creation of the world to this day. If we would form any tolerable idea of their nature, we must needs conceive, that God Almighty has laid their pipes, and canals in the earth, from a great depth, even to the surface ; like as he has planted the veins, arteries, and glands in an animal body. And likewise that they are more and more ramify'd, as they nearer approach the outward shell of the earth ; just so our veins, and arteries, as they come nearer the skin.

The workmen in coal-mines, and those of metals, minerals, and stone-quarries, never fail to

to meet with springs, and currents of water, every where. Often they ruin, and divert springs another way, only by digging into the earth for foxes, and the like. Whenever they dig for wells, in any kind of earth, they commonly find springs. The colliers, and workers of mines, are oblig'd to drain the waters off with very great expence.

These are circumstances not favorable to subterraneous fires being in the earth in abundance; much less to their being the cause of earthquakes. And further, we cannot possibly think of earthquakes doing their work that way, without absolutely ruining the whole system of springs, and fountains, throughout the whole country, where they pass. But all this is quite contrary to fact; even where an earthquake has been repeatedly. For an instance from home.

On *Wednesday, April 6, 1580*, about six in the evening, just such another earthquake was felt in *London* and around it, as these two we have seen. Another exactly similar 1692. In all these four, no houses thrown down, no springs disturb'd thereby, no sensible eruptions nor smells.

These considerations I apply only to this little inconsiderable space, of a circle 30 miles diameter; as with us. But what is that to the earthquakes we read of in history? In the

the year of our Lord 17, no less than thirteen great and noble cities in *Afia minor*, were destroyed in one night. *Tacitus*, *Pliny*, and many other authors mention it. The fact is so notorious, that some persons here present, have seen a vast block of white marble now standing near *Naples*; being the pedestal of a coloss statue of *Tiberius* the emperor; having carv'd on it the *genius's*, or pictures of all those cities, with their names. The accurate *Bulifon* and others have wrote treatises upon it. These cities were rebuilt by that emperor. But without going so far, we may see another evidence of it, a coin of that emperor struck upon the occasion, with this inscription,

CIVITATIBUS ASIAE RESTITUTIS.

I have one of them, in large brass, which was found at *Colchester*.

The compass of this earthquake may be reckon'd to take up 300 miles diameter, as a circle. Now, we cannot conceive, how any subterraneous vapour can produce such an effect, as instantaneously to demolish all these cities; and that such an accident should never happen after. That the whole country of *Afia minor* should not at the same time be destroy'd, its mountains be renversed, its fountains, springs, and rivers broken up and ruin'd for ever. Instead whereof we find nothing

thing suffered, but those cities ; no kind of alteration in the surface of the country ; it remains the same as it were in the beginning of time. In 1586 an earthquake in *Peru*, that extended 900 miles.

From these considerations, I cannot persuade myself, to enter into the opinion of vapours, and eruptions being the cause sought for ; and, after we have treated the argument in a superficial view, we must go a little deeper.

If we would consider things like philosophers, let us propose to ourselves this problem : Where is the power to be plac'd, that is requir'd to move a surface of earth 30 miles in diameter ?

To answer this, consult the ingineers, and those that make mines in the sieges of towns ; they will acquaint us, that the effect of mines is produced in form of an inverted cone. And that a diameter of 30 miles, in the base, will require an axis of 15 or 20 miles to operate upon that base, so as to shake it, at least. Now the vapours, or whatever power we propose to operate, according to the foregoing requisite, in order to form the appearance of an earthquake, must be 15 or 20 miles deep in the earth. But what mind can conceive, that any natural power is able to move an inverted cone of solid earth, whose base is 30 miles diameter, whose axis 20 ? or was

it possible ; would not the whole texture of that body of earth be quite disturb'd and shatter'd, especially in regard to its springs and fountains ? but nothing like this is ever found to be the consequence of an earthquake, tho' fatal to cities.

Apply this reasoning to the earthquake of *Aisa minor*, and this vigorous principle at the *apex* of the cone must lie, at least, 200 Miles deep in the ground. Enough to show the absurdity of any moving power plac'd under the Earth ! A cone of 300 miles diameter at base, 200 miles *axis* : I dare be bold to say, that all the gun-powder made since its invention, if put together and fired, would not be able to move it ; how much less pent up vapours ? what must we say of a circle of 900 miles diameter ?

But, could that be admitted as possible, would any one be persuaded, that such a subterraneous tumult, of so vast an extent, will be no ways injurious to the internal system of springs and fountains, and that this shall often be repeated without the least damage ? We may as well imagine, that we can stab a man 100 times and never touch vein or artery.

Since I gave in my two papers to the Royal Society, a letter of Mr. *Flamsted's* has been printed, which abundantly confirms my sentiments. The whole drift of it is, to show how invalid is the vulgar idea conceiv'd, of earth-

earthquakes arising from subterraneous vapours and eruptions: That the earth itself is not moved to any depth, and that the shock must arise from the atmosphere. The circumstances which he has judiciously collected, are extremely agreeable to mine; many of them the very same, strongly confirming my *hypothesis*: And had that great man known the properties of electricity, which we are now masters of, he would have prevented me in this affair.

" Considering (says he) what variety of substances, sand, gravel, stones, rock, minerals, clay, and mold, our earth is composed of, and how little nitre, or explosive matter, a large quantity thereof will afford; I cannot think, where we can find matter enough to move so vast a bulk of earth, as all the South parts of *England*, all the *Netherlands*, with part of *Germany*, all *France*, and perhaps *Italy*, (which were shock'd at once the 8th of *September* last 1692;) or part of *Asia*, and near all *Europe*, which trembled together the same day, 91 years before.

" But, allowing there may have been sufficient matter prepared for these purposes, I can hardly think, there are continued cavities, at any reasonable depth, all under *Europe*, wherein an explosion being made, might shake the whole at once, and yet

" make no clefts, or separations, in those
 " parts where the minerals and mountainous
 " rocks part from the light mold and clay.
 " If an hundred barrels of gun-powder could
 " be fixed in some cave, a thousand yards
 " under ground ; allowing the force of the
 " explosion sufficient to raise all the weight
 " of earth incumbent on the cavern ; it
 " would certainly break the loose mold
 " from any large solid rock we may conceive
 " adjacent, and leave at least some clefts be-
 " hind it. But we seldom or never hear of
 " such clefts, made in such places, when
 " earthquakes happen."

Again, he writes thus : " I cannot appre-
 hend, (if all earthquakes must be made by
 " explosions in subterraneous caverns) why
 " sometimes a large country, or whole con-
 " tinent, should be thereby shook all at once ;
 " why there should be no eruptions in the
 " neighbourhood ? "

From all circumstances consider'd, he con-
 cludes, that the abstruse, effective cause of
 them comes from the air ; and that a calm is
 necessary before an earthquake. And these
 two particulars are likewise Dr. Hales's pos-
 tions : " The earth-lightning, as he calls it,
 " is first kindled on the surface, and not at
 " great depths, as has been thought ; whose
 " explosion is the immediate cause of an
 " earthquake. He save long, dry, hot sea-
 " fons,

" sons, are usually the preparatory forerunners of earthquakes." From all these considerations I conclude; earthquakes are not caus'd by subterraneous vapors.

II. We are to inquire, what is the cause of earthquakes.

In an age when electricity has been so much our entertainment, and our amazement; when we are become so well acquainted with its stupendous powers and properties, its velocity, and instantaneous operation through any given distance; when we see, upon a touch, or an approach, between a non-electric and an electrified body, what a wonderful vibration is produc'd! what a snap it gives! how an innocuous flame breaks forth! how violent a shock! Is it to be wonder'd at, that hither we turn our thoughts, for the solution of the prodigious appearance of an earthquake?

Here is at once an assemblage of all those properties and circumstances which we so often see in courses of electricity. Electricity may be call'd a sort of soul to matter, thought to be an ethereal fire pervading all things; and acting instantaneously, where, and as far as it is excited. 'Tis every body's observation, that there never was a winter, like the last past, in any one's memory, so extremely remarkable for warmth and dryness, abounding with thunder and lightning,

very uncommon in winter; coruscations in the air frequent, justly thought electrical by all philosophers; particularly, twice we had the extraordinary appearance of that called *aurora australis*, with colours altogether unusual; and this just before the first earthquake: All the while the wind constantly south and south-west; and that without rain, which is unusual with these winds.

This state of the atmosphere had continued five months before the first earthquake. Is it not hence reasonable to conclude, that the earth, especially in our region, must be brought into an unusual state of electricity; into that vibratory condition wherein electricity consists; and, consequently, nothing was wanting but the approach of a non-electric body, to produce that snap, and that shock, which we call an earthquake; a vibration of the superficies of the earth.

That the earth was in that vibratory and electric state we have further reason to conclude, from the very extraordinary forwardness of all the vegetable world with us. Every one knows, that, at the end of *February*, all sorts of garden-stuff, trees, fruits, and flowers, were as forward as in other years, by the middle of *April*. Conformable to which, experiments abundantly show, that electrifying of plants quickens their growth, equally as in animals it quickens the pulse.

Nor

Nor will the unusual dryness and warmth of the weather solely account for such a precipitate vegetation : because a necessary supply of rain was wanting, as in the natural Spring-season.

A very long dry frost will produce the same electrical state of the earth, as it equally favours electrical experiments. Thus, *March 27, 1076*, a frost from the 1st of *November* to the middle of *April*, a general earthquake in *England* succeeded. *Matt. Paris.* That of *Oxford*, 17th of *September* 1683, was after a frost. *Jan. 4, 1680*, An earthquake in *Somersetshire*: The air was very calm ; a frosty night.

Mr. *Flamsted* concurs with us, in our first position, That earthquakes always happen in calm seasons. He adds, "That *Keckerman*, " a learned author, who wrote on the subject, affirms, and backs it from the authority of *Aristotle* and *Pliny*."

The 8th of *September* 1601 was a very calm day but cloudy : And the *Smyrna* merchants observe the earthquakes there happen in calm, still weather. The remarkable clearness and calmness of the morning was observed in that of *Oxford* 17th of *September* 1683, and the air continued so for five or six days after : Therefore we may infer, that it is not impossible, what has been abundantly related, that some foreigners from *Italy* here

in *England*, some from the *West-Indies* (in both which countries earthquakes are more frequent than with us) did seem to apprehend our first earthquake, from the apparent temper of the weather; and observations of this kind are as old as *Aristotle*. It is observed in *Jamaica*, when the air is extraordinary calm, an earthquake is always apprehended.

We had lately read at the Royal Society, a very curious discourse, from Mr. *Franklin* of *Philadelphia*, concerning thunders, lightning, the northern lights, and like meteors. All which he rightly solves from the doctrine of electricity. For, if a cloud raised from the sea, which is a non-electric, happens to touch a cloud raised from exhalations of the land, when electrified, it must immediately cause thunder and lightning. The electrical fire flowing from the touch of perhaps a thousand miles compass of clouds, makes that appearance which we call lightning. The snap which we hear in our electrical experiments, when re-echoed from cloud to cloud, the extent of the firmament, makes that affrightning sound of thunder.

From the same principle I infer, that, if a non-electric cloud discharges its contents upon any part of the earth, when in a high electrified state, an earthquake must necessarily ensue. The snap made upon the contact of many miles compass of solid earth, is that horrible

horrible uncouth noise, which we hear upon an earthquake ; and the shock is the earthquake itself.

In the relation received from *Portsmouth*, and the *Isle of Wight*, concerning the last shock there, on the 18th of *March*, the writer observes, the Day was warm and serene ; but, upon a gentle shower falling in the evening, the earthquake came. Here we have reason to apprehend the electrified state of the earth, and the touch of the non-electric : which caused the earthquake.

The learned Dr. *Childrey* observes, treating on this subject, that earthquakes happen upon rain ; a sudden shower of rain in the time of a great drought.

'Tis objected, that, if this was the case, nothing would be more frequent than earthquakes ; but these two circumstances concurring, a shower and dry weather, must not necessarily cause it, any more than touching a tube before it is electrified causes a snap. The earth must be in a proper electrified state to produce it ; and electricity has its fits ; is remitted, intended, ceased and recommenced. It has its bounds. All causes must concur. And now, with us, all necessary causes did so apparently. Tho' a shower of rain falling upon the earth when electrified, may cause an earthquake, yet too much rain before, will prevent that state of electricity, necessary.

The

The day before the catastrophe of *Port-Royal*, the weather was remarkably serene and clear. In that most dreadful earthquake, 1692, of *Sicily*, where 54 cities and towns, beside a great number of villages were destroy'd ; but especially the whole city of *Catania* : It was preceded by a most agreeable, serene and warm season, which was the more observable on account of its being unusual at that time of the year.

I have been inform'd, that in the morning of both earthquakes last past with us, the air was serene and calm ; on the morning before that 8th of *February*, the air was observ'd to be remarkably calm ; and that a little before, a black cloud appear'd over great part of the horizon. Dr. *Hales*, in his relation, says, the Centinels in *St. James's Park*, and others who were abroad in the morning of the last earthquake, observ'd a large black cloud, and some coruscations, just before the shock, and that it was very calm weather : And that, in the history of earthquakes, they generally begin in calm weather, with a black cloud.

This observation precludes the suspicion of earthquakes arising from tumults and commotions in the upper, or under region of the air. The remarkable clearness of the air before earthquakes, observ'd by all, shows evidently how free it is from vapours and the like.

Agree-

Agreeable to our *fifth* position, Mr. *Flamsted* writes, "A hollow noise in the air always precedes an earthquake, so near that it rather seems to accompany them. He refers us to *Philosophical Transactions*, N° 151. p. 311. The noise was heard by many that liv'd in the out-streets, and alleys of *London*, remote from the noise and tumult of the greater streets."

This he speaks of that felt in *London* 1692; but now the whole city heard the noise, on both these earthquakes of ours.

The gardener, who gave a relation to the Royal Society of what he observed in the *Temple-garden*, took notice, that first he heard the most dreadful noise imaginable, which he thought to be a great discharge of ship-guns, on the river: and that the noise rolled from the water-side towards *Temple-bar*, rather before the nodding of the houses.

The gentleman who observed it about *Hartingfordbury*, says, the noise preceded the shock. And this is a common observation, which at once both strengthens our opinion of electricity, and confutes that of subterraneous vapours; for, in the latter case, the concussion must precede the noise.

Agreeable to our *second* position, Mr. *Flamsted* writes, "That earthquakes are felt at sea, equally as on land. Our merchants say, that, tho' the water in the bay of *Smyrna*

" Smyrna lies level, and smooth as a pond ;
" yet ships riding there feel the shocks very
" sensibly, but in a very different manner
" from the houses at land : For they heave
" not, but tremble ; their masts shiver, as if
" they would fall to pieces, and their guns
" start in their carriages, tho' the surface of
" the sea lie all the time calm and unmov'd."

In Dr. Hook's *Philosophical Collections*, N° 6.
p. 185, we are told, " That a ship felt a
" shock in the main ocean ; that the passen-
" gers, who had been asleep in their cabins,
" came upon deck in a fright, fearing the
" ship had struck upon some rock ; but, on
" heaving the lead, found themselves out of
" soundings."

All this is extremely agreeable to our as-
sumption. The water receives the electrical
touch, and vibratory intestine motion of its
parts, as well as land. And the impression
may be made solely on the water a non-elec-
tric, by the touch of an electric fire-ball, or
the like ; and that seems to have been often
the case. The proper vibratory motion is
impress'd on the water without ruffling its
surface ; and so communicated to all the parts
of the ship, gives the sense of a shock to the
bottom, the shivering to the mast, and the
rest of the symptoms : which sufficiently pro-
claim the cause of it to be an electrical im-
pression upon the water. The president men-
tioned

tioned a relation of a waterman, that felt it in his boat upon the river ; he thought it like a great thump at the bottom of the boat. And so the ships at sea fancy, they strike upon a rock.

This makes us apprehend, the reason of the fishes leaping up out of the canal in *Southwark*, of which we had an account. So in that of *Oxford*, 1683, one fishing in the *Charwell* felt his boat tremble under him, and the lesser fishes seem'd affrighted by an unusual skipping. That electricity is the cause sought for, seems deducible from this consideration. Several writers on earthquakes assimilate these vibrations of the earth to those of a musical string. Experiments have shown, that fishes in water may be killed by the particular tone of a musical string ; and 'tis known, that electricity will kill animals. They assuredly felt the vibratory motion in the water, which they were absolutely strangers to before. No doubt it made them sick ; as those of weak nerves on land. And this circumstance alone precludes any suspicion of subterraneous fires under the ocean. Or, if we were to admit of it, would the boiling of the water exhibit any appearance, like what we are speaking of, either to the water, or to the ship ?

Mr. *Flamsted* likewise concurs in our eighth position, " That many people found themselves

" selves suddenly sick at stomach, and their
" heads dizzy and light; so that those that had
" formerly fits of apoplexies, dreaded their
" return; particularly, one gentleman, a sur-
" geon, feeling himself so affected, and fear-
" ing a return of his apoplexy, resolved to
" be let blood, without suspecting the earth-
" quake."

After these two shocks which we felt, many people had pains in their joints and back, as after electrifying; many had sickness, headaches, hysterick and nervous disorders, and colicks, for the whole day after, and some much longer, especially people of weak nerves, weak constitutions; some women miscarry'd upon it; to some it has prov'd fatal.

To this we must attribute, that relation we had, of the dog lying asleep before the fire; but upon the earthquake, he suddenly rose up, run about the room, whining, and endeavouring to get out.

Any solid matter is capable of being put into a state of electricity, such as iron guns; and the more so, by reason of their solidity. And in proportion to it, is the greatness of the snap, and of the shock; and a kind of lambent flame issues from the point of contact; and likewise somewhat of a sulphurous smell: So that if both flame and smell were dif-

discernible in an earthquake ; 'tis to be found, without going to the bowels of the earth.

Dr. *Hales* mentions, that solid bodies are the best conductors of aerial lightning ; whence oaks are rent, and iron melted. And in our earthquakes in *London*, the loudest noise was heard near such large stone buildings, as churches, with lofty steeples. From the top of these we must apprehend, that the electrical explosion goes off into the open air ; as by our experiments, from the point of swords, and the like.

The electrical shock is proportionate to the solid electrified, agreeable to our *seventh* position. This fully accounts for earthquakes in general, and for many in particular. What can be imagin'd greater than a shock of the body of the earth ? 'Tis greater, or less in proportion to the state of electrification. And now we can account for several appearances. In the first earthquake, the Lord Chancellor, Masters in Chancery, and several Judges, were sitting in *Westminster-Hall*, with their backs to the wall of the upper-end, which is of a vast thickness. They all relate the severity of the shock, from the wall seeming to push towards them with great violence.

And thus in the earthquake of 1692, *Deal* castle is one of them built by *Henry VIII.* the walls are of immense thickness, and strength ; yet they shook so sensibly, that the people

people living in it, expected it was falling on their heads. And this is the case in all earthquakes : the more substantial the building, the more violent is the shock : exactly the mode of electrical vibration. And this Dr. *Hales* takes notice of and others ; that an earthquake shatters rocks of marble, more easily than the *strata* of sand, earth, or gravel. In the earthquake here of 1692, a great cliff fell down near *Dover* ; and part of *Saltwood*-castle wall.

4.

'Tis from hence we account for that observation, that when we electrify any person ; upon a touch, the pain and blow of the shock is felt at the joints, the wrist, elbow, and shoulder, for instance, more than in the intermediate parts ; because *there* is the greatest quantity of solid.

At the same time, that the force of electricity in solids, is as the quantity of matter : we see most evidently, by innumerable experiments, that water is equally assistan in strengthning, and conveying the force of electricity ; and *that* in proportion too to its quantity. And hence is to be deduc'd the reason of my observation ; that the most frequent and dreadful earthquakes have fallen upon maritime places. And I find the same is taken notice of in some degree, by *Acosta*, by *Dolittle*, who wrote on that in 1692, and others.

In

In the dreadful catastrophe at *Port-Royal* then, 'tis notorious, that its violence was chiefly near the sea. So *Lima* could not suffer without its port of *Callao*. Even in those so lately felt by us, they were sensibly more violent towards the river, than farther from it.

In that earthquake which was felt in *England*, in the year 1692, (which was very much like these with us) there were no houses thrown down, nor persons kill'd : but it reach'd more particularly *Sheerness*, *Sandwich*, *Deal*, *Dover*, *Portsmouth*, and the maritime parts of *Holland*, *Flanders*, and *Normandy*.

In this that happened on *Sunday* the 18th of *March* last, at *Bath*; it was felt particularly and strongly at *Portsmouth*, seven miles above and below it, on the sea-side ; all round the isle of *Wight*, at *Southampton*, the sea-coast of *Selsey*, south of *Chichester*, *Arundel*, and the whole coast of *Sussex*, without going up the land ; and across the sea to the islands of *Jersey* and *Guernsey*.

On *Monday* night, the 2d of this instant *April*, 1750, at ten o'clock, at *Leverpool*, a shock of an earthquake. And felt in several other places in the neighbourhood ; but particularly at *Chester*, and *Warington*.

If we look into ancient history, we find 197 years before Christ, an earthquake shook

terribly the isle of *Rhodes*, damag'd many cities: and some quite swallow'd up.

Seventeen years before Christ, many cities in the isle of *Cyprus* destroy'd.

Six years before Christ, the isle of *Coos* vehemently afflicted.

During the *Peloponnesian* war among the Greeks, the isle of *Delos* shaken, and the most beautiful temple of *Apollo* thrown down.

Soon after, the city of *Lacedæmon* totally destroy'd.

A. D. 79. Three cities in *Cyprus* overthrown.

A. D. 82. The city of *Smyrna* ruined.

In the time of *Valens* the emperor, a terrible earthquake in *Crete*, whereby 100 cities were destroy'd.

Feb. 13, 1247. An earthquake, chiefly felt in the *Thames*. *Matt. Paris.*

May, 1382. A general earthquake, which did much mischief; the *Friday* following one less; the *Saturday* following, one felt mostly by water. *Henry de Knyhton. Holinshed.*

A. D. 1456, In the city of *Naples*, 40,000 people lost.

Constantinople has often suffer'd; particularly in 1509, 13,000 people overwhelm'd.

1531, At *Lisbon*, 1400 houses thrown down; as many shatter'd.

April,

April, 1690, The *Leeward-Islands*, *Montserrat*, *Nevis*, and *Antigua*: At *Martinico*, and the *French* islands, at *St. Lucia*, &c. a violent earthquake.

Dec. 8, 1703, An earthquake at *Hull*, a perfect calm.

1702, At *Strouton*, in *Argyleshire*, which extended all along the west coast of *Great-Britain*; but to no breadth on land.

Oct. 25, 1734, At *Havant*, in *Suffex*, considerable, the air perfectly calm.

But instances enough, to show what I aim'd at, that maritime places are most subject; which is a strong argument in favour of electricity; when both the solid of the earth, and the quantity of the water concur, to make the shock; exactly as in electrical experiments; when the bottle of water is held in the hand.

Thus when our mind is discharged of the prejudices of former notions, we discern, that every appearance favours the principle we go upon. That, agreeable to Mr. *Flamsted*, subterraneous explosions, could they pervade, and traverse the earth at pleasure, must at last burst, and disperse every thing in their way. Yet 'tis not possible for us to imagine, such a kind of vibration should follow, either by sea or land, as that we are treating of. But electricity compleatly answers it. This ac-

counts for that superficial movement of the earth, that universal instantaneous shock, which made every house in *London* to tremble, none to fall : That quivering, tremulous, horizontal vibration, highly different from any motion we must conceive, to be produc'd from subterraneous evaporations. Hence authors tell us, *Dec. 30, 1739*, describing an earthquake in the west-riding of *Yorkshire* : It seem'd as if the earth mov'd backward and forward horizontally ; a quivering, with reciprocal vibrations.

Mr. *Flamsted* rightly accounts the motion of earthquakes to be undulatory ; and by being continued, causes a like motion to a great distance. As when you strike a long stretch'd string of wire at one end, the motion is immediately continued to the other. So far he entered into the nature of electricity,

Tho' he be in the right, thinking the cause comes from the air, yet what follows, contradicts his own hypothesis. For if a calm be necessary before an earthquake ; then 'tis not produc'd by any turbulence in the air. Nor can we imagine that any aerial commotion, tho' it may shake windows, chimneys, and the like, shall reach 500 miles distance, split the solid earth, destroy whole cities, and cause those dire desolations we hear of.

Mr.

Mr. Flamsteed mentions a circumstance, that the earthquake here in 1692, was not felt in the north of *England*, nor in all *Scotland*: for rain fell that day in both. We may very readily conceive, the earth there was not in an electrified state; and the rain would sufficiently prevent it. We hence understand, how the southern regions should be more subject to them, than our northern; where the warmth, and dryness of the air, so necessary to electricity, is more frequent than with us.

From electric vibration only can we account for our *tenth* position, of springs, and fountains being no ways damag'd by earthquakes: The motion goes no deeper into the earth, than the force and quantity of the shock reaches; which generally is not far; yet it proceeds lower down when the ready passage of a well offers, and *there* affects the water contained in it; puts it into an intestine vibration, as to foul it, and raise mud from the bottom.

It may seem difficult to conceive, how a large portion of the earth's surface should be thus capable of electrification. This difficulty is lessened by reflecting on the nature of electricity, and of the electrical, ethereal fluid pervading all things: how it is excited by the little motion of a small revolving glass globe.

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By this we electrify the most solid bodies, to the greatest distance, and with a velocity equal to that of lightning.

Dr. *Hales* observes, that the usual explosion of the cannon on great days, in St. James's-Park, is observ'd to electrify the glafs, in the windows of the Treasury.

We must conceive, that when the electric shock is communicated to one part of the earth, it extends itself proportionably to the force of the shock, and to the quantity of electrified surface; and to the quality of the matter more or less susceptible of it, more or less apt to propagate it.

Set 1000 men in a row; let every one communicate with those next him by an iron-wire held in their hands: on an electrical shock they all feel it alike, at the same instant; and this gives us a very good idea of the earthquake.

When the earth is broken up in any large degree, 'tis by the sea-side; where sometimes on a bold shore, whole streets tumble into the sea, or into the gaping earth, now falling toward the sea. Sometimes on a flat and sandy shore, whole streets are rolled along the level into the sea.

I am not sensible of any real objection against our *hypothesis*, but this, being the eleventh of my positions, or circumstances. It seems true, that earthquakes are more frequent

quent in *Italy*, near *Vesuvius*, and by *Ætna*, in *Sicily*. And the cause seems apparently owing to these volcano's. At first sight, every one would think so, but not from the true reason. This has given the great prejudice to the judgments of the curious, even at this day. But consider the matter impartially, and it will appear, so far from being a strong argument in favour of subterraneous eruptions, that it ought to be esteem'd a convincing proof to the contrary, and most cogent in favour of my principle. In strictest logic, there is no inference to be made from particulars to generals. Quite the contrary. We have but these two or three volcano's on one quarter of the globe, and two of them toward the warmer climate of it ; whereas earthquakes are innumerable, especially in those of a warmer clime. That there are no volcano's, no discharges of fire and smoke for a continuance, and abundance, after earthquakes ; no suspicion of it either from sight or smell, as we know by innumerable examples, as well as in our own country, and experience : is demonstration, that this is not the cause. If the volcano's were the real cause of earthquakes, we ought assuredly to expect, that in the countries thereabouts, the earthquakes ought to be far more extensive than those in other countries, where are no volcano's ; but

this is altogether contrary to experience. For, as the celebrated naturalist *Buffon* observes, such are not extensive, as are near *Aetna* and *Vesuvius*. He further adds: *Histoire naturelle*, tom. i. p. 508. speaking, among many others, of a *vulcano* in the island of *Ternate*, he remarks, “ That this burning gulph is less agitated when the air is calm, and the sea-
son mild, than in storms and hurricanes;” and says, “ This confirms what I have said in my foregoing discourse, and seems evidently to prove, that the fire which makes *vulcano’s* comes not from the bottom of mountains, but from the tops, or at least from a very little depth; and that the hearth (or floor) of the fire is not far from the summit of the *vulcano’s*; for, if this was not the case, great winds could not contribute to their conflagration.” And this, in general, is a corroborative proof of my whole hypothesis. For there can be no great fire in the earth, where there is no great conveyance of air.

We have one *vulcano* in the cold region of *Iceland*, and there is sometimes an earthquake there; but, in the countries of that northern latitude, and those of lesser, ‘tis obvious in all history, that earthquakes are less frequent than in the more southern. Therefore ‘tis easy, and very natural to conclude, from all confi-



considerations weighed together, that these vulcano's help to put the earth about them, into that vibratory state and condition of electricity, which is the requisite in my *hypothesis*; and by that means only, promote a frequency of earthquakes there.

I have only one circumstance to add, which may seem not inconsiderable; probably perceived by many, tho' not taken notice of. For a whole week before the first earthquake, the partition wainscot of my house (between the forward and backward rooms) made an odd kind of tremulous, crackling noise continually, as if the wainscot would split; or as if some damage was apprehended to the house. This was observ'd by the family, with a good deal of concern. *That* in the chamber crackled more than that below. We never perceiv'd it before, nor since; and apparently, it shows the vibratory state of the surface of the earth, at that time.

But whether our conjectures upon this important subject be well founded or no, it certainly becomes a christian philosopher, whilst he is investigating material causes, to look up, and regard the moral use of them. For in reality, every thing, the whole world, was ultimately for that purpose made. When we see such a kind of spirituality impress'd on mere matter, as this amazing property of electricity, it should kindle in us a high ambition

bition of asserting, and exerting the infinitely superior value, and powers, and excellency of the spiritual part of us, destin'd to an immortal duration. And of all the great and public calamities, which affect us mortals, earthquakes claim the first title to the name of warnings and judgments. None so proper to threaten, or to execute vengeance upon a guilty people. Nor has any other, those annexed terrors, so much of the unusual, the unavoidable, the sudden and the horrible apprehension of being crush'd to death, or buried alive. And when in our own sight, these rare and extraordinary *phænomena* appear, it cannot but be a lesson to us, to do our duty toward that great Being, who, by a drop of water, can produce effects so prodigious.

That earthquakes proclaim themselves to mankind in this light, is further deducible from this obseruation, the ninth in our recapitulation of circumstances; that they are peculiarly directed to great cities, and maritime towns, those nurseries of wealth, luxury, and of all the evils naturally flowing therefrom. It would be childish to rehearse from old history, or modern, a proof of it. We have no other notices of them. Look upon these two shocks we have here felt. We own that *Hampsted-beath*, and *Finchley-forest*, and *Kennington-common* were affected with it; yet it is notorious, that *London* was the center,
the

the place to which the finger of God was pointed.

And this leads us in the *third* place, to consider the moral use and purpose of these *magnalia naturæ*, and prodigies of the agency of material causes. For nothing sure, but an electrical shock, and that from a divine hand, could have been so well adjusted, as twice, nay four times, so sensibly to shake every house in *London*, and not throw one down. This duty we will endeavour to execute, from the words of that great man, king *David*.



P S A L M

P S A L M xviii. 7.

Then the earth shook, and trembled ; the foundations also of the hills moved, and were shaken ; because he was wroth.

THIS Psalm is a triumphal song, which *David* deliver'd publickly before God, in thankful remembrance of the great mercies he had receiv'd ; being firmly established on his throne : and all his enemies, foreign or domestick, subdued.

He does not attribute this happy situation of his affairs to his own prudence and courage ; but, like a consummate politician, absolutely to the mediation of the divine providence. He draws up a most grand and magnificent description of the advent of the deity, such as words never before expressed. All the heathen pictures of the appearance of their gods, are cold and lame, compar'd to this ; which is deservedly so much admir'd by all criticks that have any taste for religion, as well as language.

This verse, in our text, is the first movement in the scene, which was to represent the appearance of *Jehovah*, without whose interposition *David* hoped for nothing fortunate. After describing all the pomp of light, and darkness,

darkness, celestial ; hailstones, thunder, lightning, and the like instances of majesty and terror, in the skies ; he still keeps his eye on the ground, and concludes with the earthquake, where he began.

Then the channels of waters were seen ; and the foundations of the earth were discovered ; at thy rebuke, O Lord ; at the blast of the breath of thy nostrils.

Our holy psalmist, at other times, has exhibited the same images, in different coloring ; as a great master varies his works, to strike out all the beauties.

Psal. lxviii. 7. *O God, when thou wentest forth before thy people ; when thou didst march thro' the wilderness ; the earth shook, the heavens also dropped, at the presence of God. Even Sinai itself was moved, at the presence of God ; the God of Israel.*

By this he means, the giving the law. Exod. xix. 8. *And mount Sinai was altogether on a smoke ; because the Lord descended on it in fire : and the smoke ascended as the smoke of a furnace, and the whole mount quaked greatly.*

Again, Psal. cxiv. when he is describing the passage over the Red-sea, and that over Jordan ; he brings in the machinery of earthquakes, to testify the divine presence.

When Israel went out of Egypt, and the house of Jacob from among a strange people ;

*The Philosophy of
the sea saw it and fled. Jordan was driven
back.*

*The mountains skipped like rams: and the
little hills like young sheep.*

Then he asks the question, *What ailed thee,
O thou sea, that thou fleddest? and thou Jord-
an, that thou wast driven back?*

*Ye mountains that ye skipped like rams, and
ye little hills like young sheep?*

He answers: *Tremble thou earth at the pre-
sence of the Lord: at the presence of the God
of Jacob.*

He fails not to attribute these marvellous appearances, to their true cause. Tho' he knew full well, that the God of nature ad- ministered the ordinary course of the earth by second causes; yet he could not be so blind but to perceive, when the waves of the ocean retreated; when the waters of *Jordan* di- vided; when mount *Sinai* was all in fire, smoke, lightning and thunder, with the trum- pet of God sounding, and the whole moun- tain shaking: he could not but perceive the presence of the author of nature, in these ex- traordinary appearances.

But every where in sacred scripture earth- quakes are particularly singled out, above all other natural *phænomena*, as having more of the majesty and terrific pomp, to denote an immediate operation of God's hand; to ex- cite our fear, and shew his anger, as in our text,

text, because he was wroth. In imitation of the sacred writers, the heathen poets, both greek and latin, express the anger of their Jupiter by an earthquake :

*Terrificam capit is concus sit terque quaterque
Cæsariem ; cum qua terram, mare, sidera,
movit.*

Ovid.

The moving meteors in the free air, lightning, coruscations, fire-balls, tempests, thunders, or the dreaded comets, tho' frightful enough ; yet people that do not think to any purpose, hope, as they are at a distance, to escape their effects. But when the terror comes home to us, to our feet ; when the earth moves on which we stand ; what heart is not moved ? When our houses *shake* over our ears, the greatest courage is *shaken*.

It is true, an earthquake causes an universal dread among all sorts of people ; even the philosopher immersed in speculation of second causes, quakes ; as well as the pious, whose fear proceeds from solid piety : a due sense of the *anger* of the almighty Being.

We saw how the late earthquakes affrighted every one ; but, as to the generality, it was but for a moment. When they found themselves safe, and alive ; thoughtless they ran to their business, or their diversion : and this not only the first, but the second time. And I am

am apprehensive, were another, and another to come, they would only be less regarded than the preceding. As the *Israelites*, to whom miracles became familiar ; as the *Jews*, in our Saviour's time, demanding of him to show them a sign from heaven, in the midst of the constant scene of miracles innumerable.

But 'tis my present busines to call you to a due and serious reflexion, on these extraordinary events ; by considering,

I. What the written word of God, the holy scriptures, informs us, concerning the ultimate purpose of earthquakes.

II. What we can learn from profane history.

III. To conclude with our text, that they are strictly and properly divine judgments ; *because he was wroth.*

Ever since the earth began, earthquakes have been look'd on as extraordinary appearances, among the prodigies of nature, and executioners of divine justice. In the case of *Korab*, *the earth opened her mouth and swallowed them up ; and their houses, and all the men that pertained unto them ; and all their goods.*

In the miraculous victory obtain'd by *Jonathan*, and his armor-bearer, over the army of the *Philistines*, I. Sam. xiv. There was a panic terror infus'd into the *Philistines*, and an *earthquake* : it is call'd *a very great trembling of*

of God. What the heathen attributed to *Pan*, an imaginary deity of their own making: the Hebrews rightly refer'd to the true cause, the first, and supreme.

In the new testament, at our Saviour's death, there was a great earthquake, which was altogether miraculous; as much as the eclipse of the sun then. The elements might well sympathize with the God of nature. *The sun was darkned, the vail of the temple was rent in twain; the earth did quake, the rocks rent.*

Again, at his resurrection, Matt. xxviii. 2. *There was a great earthquake. The angel of the Lord descended from heaven, and rolled back the stone from the door, and sat upon it.*

And for fear of him the keepers did shake, and became as dead men.

Matt. xxvii. 54. *When the centurion, and they that were with him, watching Jesus, saw the earthquake, they feared greatly.* See the consequence of it in one place; and thus in another:

Acts iv. 31. *The Apostles, in the infant church, when praying, the place was shaken, where they were assembled together: and they were all filled with the Holy Ghost.* The heathen centurion feared upon the earthquake: The christians praying, were filled with the Holy Ghost.

Acts xvi. 26. When Paul and Silas were in prison. *At midnight when they pray'd, and sang bymns to God, suddenly there was a great earthquake; so that the foundations of the prison were shaken. And immediately all the doors were opened, and every one's bands were loosed.*

Observe the consequence it had upon the goaler; *He called for a light, and sprang in, and came trembling, and fell down before Paul and Silas, and said, Sirs, what must I do to be saved?*

The goal trembled; and the goaler trembled, as is observed by a writer on this head, an earthquake could soften his hard heart, and open what he had lock'd. It awaken'd him out of his spiritual slumber, as well as his natural sleep, and made his conscience, as well as the foundations of the prison, to quake. A bad conscience is *as a troubled sea, that cannot rest, but casteth up mire, and clay.* The goaler perceiv'd the celestial warning, and made a proper use of it.

There are many circumstances in the nature of earthquakes, which render them peculiarly proper to be the instruments in God's hand, to give warning to a people, to amend their ways.

The *suddenness* is one. We saw, not long ago, what an effect was produced by a solar eclipse,

eclipse, tho' it was expected long before. We had the prediction, and calculations about it in all our almanacs; yet there was an universal seriousness that followed it. All that morning, we could walk the street, without hearing an oath, and the churches were full, in time of prayer. But the *suddenness* of an earthquake that comes at an instant, unthought of, without warning, that seems to bring unavoidable death along with it; is able to touch an adamantine heart. To see death stalking o'er a great city, ready to sweep us all away, in an instantaneous ruin, without a single moment to recollect our thoughts; this is fear without remedy; this is far beyond battle and pestilence. The lightning and thunderbolt, *the arrow that flieth by day*, may suddenly take off an object or two, and leave no space for repentance: but what horror can equal that, when above a million of people are liable to be buried, in one common grave!

Another consideration that enhances the dread of earthquakes, is the *unavoidableness* of the calamity. Famine, and war, and rebellion, and pestilence we may run from, the disease among the cattle, and locusts, and the like stripes of angry heaven, we may have some chance to escape: but no means, no precaution, no remedy, no prudence can screen us, from so universal a desolation as this: 'tis

as the presence of God. Whither then can we go to hide ourselves? Must we call upon the rocks and mountains, to cover, and shelter us from the divine wrath! *And they shall go into the holes of the rocks, and into the caves of the earth, for fear of the LORD, and for the glory of his majesty; when he ariseth to shake terribly the earth.* Alas, those are the very instruments he employs for our destruction; to be our tombstones!

This *unusual* kind of death too, strikes us with horror; to be buried alive. The earth, the common mother of us all, and the common grave; to eat up her offspring alive; crowds all the images of amazement together, that can enter into the heart of man.

The greater the terror accompanying earthquakes, the greater a blessing is our deliverance from the danger of it! What can equal God's power and judgment but his mercy? Consider the wonderful consequence; that the whole city of *London* should so sensibly be shaken, and yet no one inhabited house to fall; nor one person kill'd. Amazing instance of power, and goodness, in our preservation! And this not only once, but the second time also; tho' evidently stronger was the concussion. So strong that almost every person was throughly persuaded, that some part, at least, of their houses, was falling down. Can we help

help admiring, that judgment should be so temper'd with mercy ! Do we look only at the second causes with our unbelievers ; and sport away the divine presence, as if it was an ordinary occurrence of every day ? They want to see a miracle. Nought can affect them, but a direct, supernatural agency.

I answer, behold a visible, and notorious miracle; plainly obvious, and before all their fenses. For can there be a greater miracle, can any thing be more directly the finger of God than this, which we ourselves saw with our eyes ; that befell the whole city of *London*.

We know the nature of the building of *London* houses ; which sometimes fall of themselves, without shaking. Wonderful then is it to be thought, and a miracle indeed, that every house in this vast city, should twice be agitated, and rocked to and fro ; and not one fall, nor one person receive any damage.

In vain will the philosophers seek for a solution of this problem, in natural causes only. By their chymical experiments, they make some little mimic imitations of tremors and fumes, and explosions. So by gun-powder, we ape the regal voice of thunder. But where is the discretionary act of mercy, and benignity, that separates between the vengeful and kind ? These second causes act according to their

material nature, like the roaring waves of the ocean, that flow in, and overwhelm every thing, where a breach is made. They can observe no distinction between the lands of a righteous man, and of a sinner : they cannot stop at the breach, and gather themselves on an heap, and not enter in at all, as the waters of *Jordan* did.

But in the case before us, the hand of the Lord, that stayed the flowing of the waters, that quelled the raging of the sea, and its proud waves ; sets bounds to the trembling of the earth. Hither shall its vibrations go, and no further. When alas, if it went but one inch further (in comparison) a total ruin must unavoidably follow.

Consider this particular, when apply'd to all the buildings in this immense city : and wonder and adore, that almighty providence, which overlook'd us, and prescrib'd the limits ; so narrow, so precise ; which sav'd us from universal havoc !

II. Did we escape ; how much happier are we, than the millions that have perished by the like calamity ? *Josephus* the famous Jewish historian records, that about 29 years before our Saviour's birth, there happened such an earthquake in the country of *Judea*, that 30,000 men perished.

In

In the fifth year of the reign of *Tiberius*, so dreadful an earthquake happened in *Asia minor*, that no less than 13 cities were destroy'd in one night; many of them great, and Royal: *Sardis* in particular, said to be second to *Babylon*.

In *A. D.* 66. Another earthquake happen'd there, which destroy'd *Laodicea*, *Hierapolis*, and *Colossus*.

A. D. 79. Three cities in *Cyprus* were overthrown.

A. D. 114. The city of *Antioch* suffered extremely; whilst the emperor *Trajan* was in it. And in the 7th year of that emperor, nine several cities were destroy'd in *Asia*, *Greece*, and *Calabria*.

To come nearer home, and our own times: In 1169, *Catania* in *Sicily* was destroyed, and 15,000 people killed.

1692, The whole city destroy'd and 18000 Inhabitants.

1456, At *Naples* 40,000 perished by an earthquake.

1531, In the city of *Lisbon*, 1400 houses were overthrown there, besides many damaged.

We know the miserable and deplorable catastrophe of *Port-Royal*, in *Jamaica*; which fell out in our own days. My blood shudders at the relation of it. And not many

months ago, the populous *Lima* in *America*, was wholly swallowed up.

Have we not reason then to fear, for ourselves? 'Tis true, we have hitherto escaped. But can we tell how soon God shall let loose the avenging power of another; which may come, for ought we know, while we are speaking of it. And if it must come, happy may it be for us, that it finds us in this place, and so doing.

III. And this brings us, to consider the uses of these admonitions; and to show, that they are the effects of the divine anger. *For the earth shook and trembled*, says the holy psalmist, *the foundation of the hills moved and were shaken*; because he was wroth.

And here we cannot possibly have a stronger and more convincing evidence, of these convulsions of nature, being the immediate finger of God, than this single consideration. Let us but reflect on what has been said, in short; that these visitations only happen to great and populous cities, to great and eminent ports, and maritime emporiums flourishing in trade, riches, and luxury.

We hear not of barren desarts, uninhabited wildernesSES, wide heaths, and downs, rocky cliffs, and beaches of the sea, to be the usual subject of earthquakes: but of towns and cities. Not so much of little villages,

but

but of those immense collections of people. God does not give his warnings to birds, and beasts of the forest ; to flocks of sheep ; that punctually execute the respective offices he has enjoined them : but to us, the lords of the creation ; to whom he has given reason, sense, and faculties, to reflect, and judge of things, of our own actions, as well as his ; of *his* doings, toward the children of men.

We observed before, a plain and notorious proof of God's hand in these judgments ; that he cou'd move a whole city without throwing down a house. And this is most assuredly a second proof ; that he visits *only* great cities, with these judgments. And we must conclude this to be as strong an argument of a divine interposition in these affairs, as any mathematical demonstration.

Some free-thinkers, or free-livers, when they find, they cannot set aside this reasoning, shelter themselves, with the history of God's converse with *Abraham* ; about the cities of *Sodom* and *Gomorrha* ; assuring themselves, there is no danger. For tho' they can't pretend to be the meritorious people ; yet they think God's mercy will be as signal to us, as heretofore : and that we have among us, at least ten righteous persons, to save the rest.

But

But vain are such hopes : God will say to them, as heretofore to the Jews : *If I bring my great judgments upon the earth, as I live saith the Lord, tho' Noah, Daniel, and Job were there ; they should save neither sons, nor daughters, but their own souls only.*

God can, if he pleases, by very extraordinary means, preserve such as he thinks fit. But in general judgments, the righteous must undergo one common fate, with the wicked. God's mercy will be shown to them after this life, to make the superabundant amends.

But this is a solid lesson to us, of the necessity of a future life. We may as well banish God out of the earth, as to deny his attributes of power, and goodness, and justice, and the like. And these will insure us of a future state ; when an exact return will be made, for our behaviour in this ; otherwise we might justly expostulate, as Abraham did, *Will not the judge of all the earth do right ?*

Good men, who have endeavour'd to do their duty, may say, *God is our refuge and strength, a very present help in trouble. Therefore will not we fear, tho' the earth be remov'd ; tho' the mountains be carried into the midst of the sea ; tho' the waters thereof roar, and be troubled ; tho' the mountains shake with the swelling thereof.*

Come

Come behold the works of the Lord ; what desolations he hath made on the earth.

In the mean time, let us not think on running away from the danger, so much as on mending our ways ; perfecting the christian life ; reforming the abominable crimes, so justly chargeable on great and maritime cities ; overflowing with riches, pride, and luxury, with vanity, pleasure, and profaneness ; with gaming, immorality, infidelity ; and especially with the notorious crime of sabbath-breaking, which is the foundation of all, and comprehends all others ; for it prevents people from amending of any. If they fail of their duty towards God, in making their regular approaches to his temple ; no wonder they are guilty of all crimes ; regard neither God nor man. If they fail of coming, where they may hope for the kindly influences of God's holy Spirit ; we need not wonder at their egregious wickedness : they become absolutely irreclaimable.

But of you, my beloved brethren, here assembled, I hope better things. You shun the degenerate corruptions of this evil age ; you are not of the number of those that frequent our public meetings of folly, from the morning rendezvouzes to the mid-night assemblies ; and *that* protracted to the morning light again. As if we ought to banish all serious

rious thoughts of our immortal interests ; and that in the sacred season of lent ; destin'd by the church, for this very serious purpose.

Let us think, how this warning happen'd to us, in the time of lent ; when they were revelling in their places of entertainment, both morning and evening, as if no such thing had been ; and this on the very days ; as if they confronted, and dar'd almighty vengeance. Much of a parallel case with that of the famous city of *Herculaneum*, which is now the entertainment of the curious. First it was miserably shatter'd by an earthquake ; whilst the people were at their diversions in the theatre ; where all assembled perished. This was in the first year of *Titus* the emperor : but such a partial judgment not mending their manners ; 9 years after, the whole city was destroy'd by a lake of liquid fire and brimstone, from mount *Vesuvius*, just in the manner we now find it ; 50 foot deep in cinders, and ashes.

*When thy judgments, O God, are abroad,
the inhabitants of the earth will learn righteousness.*

The Lord is the true God ; he is the living God ; the everlasting King : At his wrath, the earth shall tremble, and the nations shall not be able to abide his indignation ; says the prophet Jeremiah, x. 10.

God

God give us grace, that instead of these short-liv'd, and unsatisfying pleasures; instead of palaces and houses here, ornamented in a sumptuous and elegant *taste*; which may perhaps be swept away, with their owners, in a moment; we may aspire towards that heavenly city, which is above; whose foundations are not laid with hands, eternal in the heavens, &c.

F I N I S.



THE
PHILOSOPHY
OF
EARTHQUAKES,
NATURAL and RELIGIOUS.

P A R T II.

Philosophi ipsius, qui de sua vi ac sapientia unus omnia pene profitetur, est tamen quædam descriptio; ut is qui studet omnium rerum divinarum atque humanarum vim, naturam, causasq; nosse: & omnem bene vivendi rationem tenere, & persequi; nomine hoc appelletur.

Cicero de Oratore.

By WILLIAM STUKELEY, M. D. Rector
of St. George's, Queen-Square: Fellow of the
College of Physicians and Royal Society:

L O N D O N:

Printed for C. CORBET over-against St. Dunstan's
Church, Fleetstreet.

M D C C L,

P R E F A C E.

THIS discourse is but a necessary consequence of the preceding. The whole no other than an essay, toward investigating the true nature of the wonderful appearance of an earthquake. And something is done toward it, if only by eradicating an old error. In attaining the proposed end, I have endeavour'd to lay all the necessary circumstances together, which to our great amazement we have seen, and felt. That they may not be as soon forgotten, as they generally were, by the giddy multitude; equally thoughtless of what they knew to be past, as childishly fearful of an imaginary one; subsequent: for which there could not be the least ground of apprehension. By sober persons it was, with great reason, thought a judicial infatuation, and as much to be wonder'd at, as an earthquake itself; a real panic. When a third part of this immense city ran out into the fields for half a cold night; alarm'd with the silly prediction of a distemper'd fellow!

Nothing could tempt one to commemorate the follies of our contemporaries, but the hope,

P R E F A C E.

it may be useful hereafter : and to show the true cause of this senseless terror ; the want of a true sense of religion ; and an universal degeneracy, and corruption of manners : begun by the great ones, and now propagated thro' all degrees to the lowest : begun in this great city ; and now advancing apace to every great town in the kingdom.

'Tis from the great ones alone, that we can hope for a reformation : and that by a strict observance of the sabbatical duty. Example, we know, governs the actions of mankind. That must restore the practice, and the influence of religion : which alone can prevent the dangers that infest every corner of our streets ; every road in the kingdom. We mistake the point, and betray our ignorance in human nature, when we think, acts of parliament, laws, and executions will do it. They are very weak in comparison of the impressions of religion, and conscience : as all philosophy both natural and religious, has hitherto thought, and known.

T O

T O

Martin Folkes, Esq; LL. D.

President of the Royal Society.

SINCE I had the honour to lay before the Society, in the spring, my thoughts upon earthquakes : we have had many further opportunities of reflecting upon that most awful, and hitherto unusual appearance. An earthquake was felt at *Eastwell* in *Kent*, on *monday march 12*, and on *sunday, march 18*, at *Portsmouth*, the *Isle of Wight*, *Southampton*, and along the coast of *Sussex*, the isles of *Guernsey*, *Jersey*. *April 2*, a smart earthquake at *Manchester*, *Liverpool*, *Taunton*, *Bath*, *Flint*, *Lancaster*, *Wrexham*, reaching 40 miles north and south : 70 miles east and west. Since then at *Rome*, *Naples*, *Leghorn*; in the south of *France*, and at *Pau* under the *Pyrenean* mountains: *Oporto*, at *S. Macaire* in *Guienne*, *Messina* in *Sicily*, *Munich* in *Bavaria*, &c. &c. so that the year 1750, may rather be called the year of earthquakes, than of jubilee. For since

February last, when they began with us at *London*; as far as I can learn, they have appear'd in many parts of *Europe, Asia, Africa*, and *America*. And have likewise revisited many counties in our own island, and at length, on the 30th of last *September* gave much the most extensive shock, we have seen here in our days.

It may be well expected, that these frequent visits, in themselves so very extraordinary, to us so rare, and *that* in one year, should keep up our attention: and as to my own part, induce one to reflect, on what I before offer'd concerning them; and be a sufficient apology for the present paper.

We have been acquainted, by those who remember it, that in the earthquake of *Nov. 1703*, which happen'd in *Lincolnshire*, the weather was calm, close, gloomy, warm, and dry; in a degree highly unusual, at that season. And thus it has been with us, all the year. And from the numerous accounts we have receiv'd at the Royal Society, in the beginning, and ending of the year; where any mention is made of the weather; they all agree in the like particular. Which is consentaneous to what I remark'd, as the constant forerunner of earthquakes; and what prepares the earth's surface, for the electrical stroke: which I asserted to be the cause of them.

In

In *May* last, we had a paper read at the Royal Society, concerning the second earthquake felt by us at *London*, on the 8th of *march*. A shepherd belonging to Mr. Secretary *Fox* at *Kensington* (the sky being perfectly serene, and clear) was much surprised with a very extraordinary noise in the air, rolling over his head, as of cannon close by. He likewise thought, that it came from the north-west, and went to the south-east: a motion quite contrary, to what must have been the case, if it were really of cannon. This noise pass'd rushing by him; and instantly he saw the ground (a dry, and solid spot) wave under him, like the face of the river. The tall trees of the avenue, where he was, nodded their tops very sensibly, and quiver'd like a shaken spear. The flock of sheep immediately took fright, and ran all away together, as if dogs had pursued them. A great rookery in the place, were equally alarm'd, and after an universal clangor, flew away; no less than if chaced by hawks.

I was likewise inform'd, that in the same earthquake, a great parcel of hens, and chickens, kept at that time in *Gray's-inn-lane*, upon the shock, ran to the roost, affrighted. And the like was observ'd of pigeons. And in our last account of the earthquake from *Northampton*, 'tis remarked, that the birds in

cages put their heads under their wings, as to hide themselves.

June 21, at the Royal Society, Mr. Jackson potter at Lambeth, gave an account of some boats, cobles and lighters in the river, at that time; the people in them seem'd to feel, as if a porpoise, or some great fish had heav'd and thump'd at the bottom of the vessels. This is sometimes the case of ships at sea, when all is perfectly calm: which seems evidently owing to an electrical impression on the water.

In the evening-post of June 23, we had a paragraph from *Venice*, that a terrible earthquake had been felt lately in the little rocky isle of Cerigo, in the *Mediterranean*, south of Morea. It threw down a great number of houses; and above 2000 of the inhabitants were buried in the ruins.

Another earthquake about that time, happen'd in *Switzerland*; which split a vast, rocky mountain; and an old castle wall of an immense thickness.

All these circumstances, and many more confirmed me in my former opinion. But since then, these wonderful movements have stalk'd round the globe: and again been lately felt in our own island; happily for us, to the terror only, of many thousand people: beside those concussions of this sort that appear'd in the western parts, in the more early time of the year. I

I receiv'd a letter from my friend *Maurice Johnson*, Esq; the founder, and secretary of the Literary Society of *Spalding*; which has now subsisted these 40 years. He acquaints me, that on *Thursday, 23d of August* last, an earthquake was very sensibly felt there, about seven o'clock in the morning; throughout the whole town and neighbourhood; and many miles round: but that it chiefly spread itself northward, and southward. He says, that for a fortnight before, the weather had been serene, mild, and calm. And one evening, there was a deep red *aurora australis*, covering the cope of heaven, very terrible to behold. This same shock was felt at *Grantham, Stamford, and Milton by Peterborough*; and generally at all the intermediate places: and from *Spalding* it fled northward, along the sea shore, to *Boston*: thence up *Boston river*, to *Lincoln*.

Since then, I had a letter from Mr. Alderman *Taylor of Stamford*, giving an account of another earthquake, that happen'd there, *September 30*, at 36 minutes after twelve o'clock at noon. He describes it thus. They were suddenly surprised with an uncommon noise in the air, like the rolling of large carriages in the streets, for about 20 seconds. At the same instant they felt a great shake, or snap, as he calls it; insomuch that it sensibly shook a punch-bowl, which was in his parlour, and made

made it ring. He says, it was perceiv'd of most of the people of *Stamford*, who generally ran out of their houses. At *Oakham* the chief town of *Rutland*, the congregation ran out of the church whilst the preacher was in the pulpit. All the towns round *Stamford*, were sensible of it : and at *Peterborough*, down to *Wisbech*.

Thus far the Alderman. But we have had many advices from all hands, at the first, and second meetings of the Royal Society, for the winter season; with further particulars relating to this great concussion. That it was felt at the same time, at *Rugby* in *Warwickshire*, and reach'd to *Warwick*, at *Lutterworth*, in *Leicestershire*: at *Leicester*, and round about. It extended itself to *Coventry*, *Derby*, *Nottingham*, *Newark*; then came eastward to *Harborough*, *Towcester*, *Northampton*, *Rowel*, *Kettering*, *Wellingborough*, *Oundle*, in *Northamptonshire*; *Uppingham*, *Oakham* in *Rutland*; *Stamford*, *Bourn*, *Grantbam*, *Spalding*, *Boston*, and to *Lincoln* in *Lincolnshire*; *Holbech*, and all *Holland* in that county. *Peterborough*, *Wisbech*, in the isle of *Ely*; together with all the intermediate, and adjacent places. Then it pass'd over the whole breadth of *Ely* fen: was felt at *Mildenhall*, and reach'd to *Calford* by *Bury* in *Suffolk*, and the country thereabouts; of which we had notice from lady *Cornwallis*. An extent from *Warwick*

Warwick to Bury of about 100 miles in length ; and generally speaking, 40 miles in breadth. And this vast space was pervaded by this amazing motion, as far as we can get any satisfaction, in the same instant of time. They describe it, that the houses totter'd, and seem'd to heave up, and down : tho' it lasted but a few seconds. It was attended with a rushing noise, as if the houses were falling, and people were universally so affrighted, as to run out ; imagining that their own, or their neighbours houses were tumbling on their heads. In the villages around, the people being generally at divine service, were much alarm'd : both with the noise, which exceeded all the thunder they had ever heard, beyond compare : and with the great shock accompanying ; which was like somewhat, as they imagin'd, that rush'd against the church-walls, and roof. Some thinking the pillars crack'd, many that the beams of the roof were disjointed ; and all, that the whole was falling. And happy were they that could get out first. Many people fancied, that nests of drawers, and cabinets, or the like heavy things, were fallen down above stairs : or that chimnies had broke thro' the roof of the house : or that some persons fell down stairs : and the like. Some perceived the crackling of inward wainscots or partitions : as Dr. *Mortimer* and I, observ'd in our first and second shocks

shocks at *London*. A few slates, tiles, and parts of chimneys fell from some houses : pewter, china, glasses and brass from shelves. A clock bell, chamber bell sometime struck : windows universally rattled, and the like circumstances of tremor.

In regard to circumstances, they were pretty similar throughout. Many people sitting in their chairs relate, that they and their chairs were several times sensibly lifted up and set down again. A stack of chimneys were thrown down in *College-lane*; a place retaining the memory of a sort of university once beginning at *Northampton*. The windows of houses rattled throughout the whole town : but no mischief done : in general it was frightful, and innocuous.

They fancied there, the motion of it, as they expressed it, to be eastward. In streets that run north and south, the houses on the east side of the way, were most affected. And Dr. *Stonehouse's* dwelling, the strongest in the town, was most sensibly shaken. So it was likewise observ'd, that churches were most subject to its violence. They thought too, that the motion seem'd rather horizontal, or lateral, than upward. Some counted the pulses distinctly, to the number of four: that the second, and third pulses were stronger, than the first, and fourth.

From

From all these various accounts, there was no sulphureous smell, or eruption; no fissures in the ground perceived. Yet several people were sick upon it: infinite numbers terribly affrighted, and as soon forgot the impression of it; or talk'd of it in a merry strain; as commonly with us at *London*. So little are the vulgar affected, without something very sensible; and so soon is the sense of it worn out!

It was more evidently perceiv'd, by people standing; most, by those that were sitting: least, by such as were walking: and in upper stories of houses, more than in lower; or in cellars. Some coming down stairs, were in danger of being thrown forwards. Several sitting in a chair, and hearing the hollow, thundring noise, and thinking it was a coach passing by; when they attempted to get up, to see what it was, they were thrown back again in their chair. Some heard the wainscot crackle. Some sitting in their chairs leaning forwards, were thrown down on their hands, and knees. Some people heard the noise without feeling the shock: others felt the shock without hearing the noise. Some in a standing posture, were forc'd to lay hold on a table, to keep themselves from falling.

It was particularly remarked (as before observ'd) that birds in cages were sensibly affrighted; thrusting their heads under their wings.

wings. Mrs. *Allcock* of *Loddington, Northamptonshire*, a lady in child-bed, was so affected, that it caused her death. Mrs. *Hardy*, another lady in the same circumstance, and in the same county, likewise expired upon it. Some people felt a sudden shortness of breath, that they were forc'd to go out into the open air, it so affected the pulmonary nerves. Many were taken with head-achs, and other sicknesses.

These are, in general, the circumstances and observations made, at the time of these earthquakes; when we recollect ourselves, after the suddenness, and fright. Give me leave to make the following remarks therefrom.

1st. As far as we can possibly learn, where no one can be prepar'd, at different places, by time keepers; this mighty concussion was felt precisely at the same instant of time; being about half an hour after twelve at noon. This, I presume, cannot be accounted for, by any natural power, but by that of an electrical vibration; which, we know, acts instantaneously.

2dly, Let us reflect on the vast extent of this trembling, 100 miles in length, 40 in breadth, which amounts to 4000 square miles in surface. That this should be put into such an agitation, in one moment of time, is such a prodigy; as we should never believe, or conceive,

conceive, did we not know it to be fact, from our own senses. But if we look for a solution of it, we cannot think, any natural power is equal to it, but that of electricity; which acknowledges no sensible transition of time; no bounds.

3ly, We observe, the vulgar solution of subterraneous eruptions receives no countenance, from all that was seen, or felt, during these earthquakes. It would be very hard to imagine, how any such thing could so suddenly, and instantaneously operate, thro' this vast space: and *that* in so similar, and tender a manner over the whole, thro' so great a variety, as well as extent of country; as to do no mischief. A philosophical inquirer in *Northamptonshire*, who had his eye particularly on this point, takes notice, there were not any fissures in the ground; any sulphureous smells, or eruptions any where perceiv'd; so as to favour internal convulsions of the earth. The reverend Mr. *Nixon* of *Higham*, and Mr. *Smith*, in his letter from *Peterborough* take notice, that they could not learn, there were any sort of eruptions out of the earth, any where: no smoke, vapor, or smell: tho' they made sufficient inquiry about that circumstance, according to particular direction. Yet we learn from a letter at *Uppingham* in *Rutland*, that a plaster floor became crack'd thereby. These kind of floors are frequent in

in this country ; what we call *stucco* in *London* : and it gives us a good notion of the undulatory vibration, produc'd by an earthquake ; which some have compar'd to that of a musical string : others to that of a dog, or a horse shaking themselves, when they come out of the water. This last comparison would have pleased some of the ancients, who would needs fancy, that the globe of the earth was a great animal. *Plato*, *Plutarch*, and others, had such kind of sentiments. Whence one may imagine, that they would conceive an earthquake to be, as when a horse shakes a part of his skin, upon a fly touching him. Some of our correspondents express the motion of an earthquake to be like a boat lifted up by one wave, let down by another.

4ly, The former earthquake that happen'd at *Grantham*, *Spalding*, *Stamford*, (which towns lie in a triangle) took up a space which may, in gross, be accounted a circle of 30 miles diameter : the center of which is that great morass, called *Deeping-fen*. This comprehends 15 miles of that 30, in diameter : and where probably, the electrical impression was first made. Much the major part of *Deeping-fen* is under water in the winter time ; underneath 'tis a perfect bog. Now it is very obvious, how little favorable such ground is, for subterraneous fires,

In

In the second earthquake, not only this country was affected again, but likewise a much larger space of the same sort of fenny ground, rather worse than the former : all *Donnington-fen*, *Deeping-fen*, *Croyland-fen*, *Thorney-fen*, *Whittlesea-fen*, *Bedford* level, and the whole extent of *Ely-fen*, under various denominations. This country, under the turf, abounds with subterraneous timber of all sorts ; fir, oak, and brush-wood : and stags horns. Now and then they find a quantity of hazel nuts, crowded together on an heap. I have some of them. This is a matter common to all boggy ground over the whole globe. Such things are the ruins of the *antediluvian* world, washed down from the high country where they grew, were here lodg'd upon the subsiding of the waters, and by time are o'ergrown with the present turf. They that seek for any other solution of this affair, than the universal *Noachian* deluge, want to account for a general effect, by a partial cause : and shut their eyes, both to the plain history of this matter ; and to the infinite, notorious demonstrations of it, from fossil appearances.

5ly, All this country, tho' underneath 'tis a watry bog, yet thro' this whole summer, and autumnal season (as they can have no natural springs in such a level) the drought has been so great on the superficies, that the inhabi-

tants were oblig'd every day, to drive their cattle several miles, for watering. The drought was greater, than has been known in the memory of any one living. This shows how fit the dry surface was, for an electrical vibration. And we learn from hence, this important particular, that it reaches but very little below the earth's surface.

Mr. *Johnson*, in another letter which he wrote to me concerning the second earthquake observ'd at *Spalding*; says upon this occasion, he was obliged to scour his canal, and deepen it: that they came to a white, quicksand; which afforded to all the neighbourhood, excellent water in plenty.

In the gravelly soil of *London*; and where the two shocks were felt by us, in the beginning of the year; we know, there is not a house in the whole extent of this vast city, and all around it, but a spring of water is ready, upon digging a well. Whence we have much reason to believe, that the interior of the earth, is like a sponge soak'd in water. So that the only dry part is the superficies, which is the object, and the subject of that electric vibration; wherein, according to my sentiments, an earthquake consists.

This shews the mistake of the ancients, who fancying that earthquakes proceeded from subterraneous eruptions, built their prodigious temple of *Diana* at *Ephesus*, upon a boggy ground,

ground, to prevent such a disaster. The marshy part of *Lincolnshire*, being my native country, the adjacent fen, together with that in the isle of *Ely*, I have been perfectly acquainted with ; from one end to the other, ever since I knew any thing. This vast extent of fenny level, from near *Cambridge* in the south, to near *Horncastle* in the north, is 70 miles in length. And when I perceiv'd, that it was, in whole, or in part, shaken by both the last earthquakes : I could not but see, that it was no less than a demonstration against the old notion of their cause.

6ly, Earthquakes are truly most violent, in a rocky country : because the shock is proportionate to the solidity of the matter electrify'd. So that rocks, cliffs, quarries, old castle walls, and strong buildings, are most obnoxious to the concussion. The isle of *Cerigo* was more liable, and more rudely handled by the late earthquake ; both because it was an isle, and because it was rocky. So we must say of the late earthquake in *Switzerland*, that split the mountain, and the old castle wall. Whence Mr. *Johnson* in his second letter, says, it cracked a very strong brick-house in *Gosberton* by *Spalding*. Dr. *Doderidge* observes from *Northampton*, that Dr. *Stonehouse*'s dwelling being a very strong one, was most sensibly shaken. And throughout the whole compass of this great earthquake, we find, both

the noise, the shock, and the terror was greatest at the churches, whose walls and bulk made more resistance than houses. And generally speaking, the churches throughout this whole extent have very fair, and large towers, and very many remarkable spires all of good stone, which no doubt quiver'd very much at top, if we could have discern'd it. This same vibration impressed on the water, meeting with the solid of the bottom of ships, and lighters, gives that thump felt thereon; just as in common electrifying, we feel the stroke upon the joints of our limbs chiefly. Yet of the millions of ordinary houses, over which it passed, not one fell. A consideration which sufficiently points out to us, what sort of a motion this was not, what sort of a motion it was, and whence deriv'd ; not a convulsion of the bowels of the earth, but an uniform vibration or undulation of its surface, aptly thought like that of a musical string : or what we put a drinking glas into, by rubbing one's finger over the edge ; which yet brought to a certain pitch, breaks the glas ; undoubtedly an electric repulsion of parts. And from this remarkable similiarity in the appearance of earthquakes we gather an invincible argument against the old opinion of their cause ; for the tumult of subterraneous eruptions can have no possible place herein.

7ly,

7ly, We find from all accounts, ancient and modern, that the weather preceding these shocks, was mild, warm, dry, serene, clear, frosty : what notoriously favours all our electrical experiments. This is particularly observ'd by Mr. *Johnson* and Mr. *Smith*, and other accounts. In the extensive shock of *sunday march 18*, along the *Sussex* coast, they take notice from *Portsmouth*, that the day was serene, warm, and dry, and that a shower of rain fell immediately before the shock. Mr. *Bowman* of *Moulsey* observ'd a shock there on *may 24* last, and says, the air was perfectly serene, and clear. We very well know, that generally, all last winter spring, summer, and autumn, have been most remarkably of this kind of weather ; more so, than has been observ'd in our memory ; and have had all those requisites, appearances, and preparations, that notoriously cause electricity, that promote it, or that are the effects of it.

8ly, We find the blood-red *australis aurora* preceding at *Spalding*, as with us at *London*. At the time of the earthquake at *Manchester* this year, it accompanied it. And this year has been more remarkable than any for fire-balls, storms, wind, thunder, lightnings, and coruscations, almost throughout all *England*. A large ball of fire, with a long fiery tail on *july 22*, that passed over great part of *England* northward. Another seen over *London*,

passing from west to east, in *october*. Coruscations were seen just before that extensive shock of 70 miles long felt from *Lancaster* to *Wrexham*, on *april 2*; last. Fire-balls more than one were seen in *Rutland*, and *Lincolnshire*: and particularly observ'd. And Mr. *Smith* from *Peterborough* writes, that a fire-ball was seen the morning of the earthquake, in the upper part of *Northamptonshire*. All these kind of meteors are rightly judg'd to proceed from a state of electricity in the earth and atmosphere: and how far they are actually concerned in causing earthquakes, time, and accurate observation must inform us.

gly, Mr. *Johnson* in both his letters to me, on the first and second earthquakes, at *Spalding*, remarks particularly, of their effects being mostly spread to the north and south, and especially felt on the sea coast. We may observe, that such is the direction of *Spalding* river, which both conducts, and strengthens the electric vibration: conveying it along the sea-shore thence, up to *Boston* channel; and so up *Boston* river to *Lincoln*, as we discern, by casting our eye on a map.

We observe further, that the main of this second earthquake display'd its effects along, and between the two rivers, *Welland* and *Avon*: and that from their very origins, down to their fall into the sea. It likewise reach'd the river *Witham*, which directed the electric stream that

that way too, to *Lincoln*. For which reason, as there meeting the same coming from *Boston*, the shock was most sensibly felt. It reach'd likewise to the *Trent* at *Nottingham*, which convey'd it to *Newark*.

The first electrical stroke seems to have been made on the high ground above *Daventry*, in *Northamptonshire*; where the *Roman* camps are, made by *P. Ostorius* the proprætor. From thence it descended chiefly eastward, and along the river *Welland*, from *Harborough* to *Stamford*, *Spalding*, the sea: and along the river *Avon*, or *Nen*, to *Northampton*, *Peterborough*, *Wisbech* to the sea. It spread itself all over the vast level of the isle of *Ely*; further'd by very many canals, and rivers, natural, and artificial, made for drainage. It was still conduct-ed eastward up *Mildenhall* river, in *Suffolk*, to *Bury*, and the parts adjacent. All this affair duly consider'd, is a confirmation of the doc-trine I advanc'd on this subject.

Ioly, I apprehend, it was not the noise in the air, as of many cannon let off at once, preceding the earthquake, that so much affrighted people, or affected the sheep, the rookery at *Kensington*, the hen and chickens in *Gray's-inn-lane*, the pigeons. It could not be barely the superficial movement of the earth, that dis-turb'd them all at once. I judge it to be the effect of electricity, somewhat like what causes sea sickness; such a sort of motion, as we are

not accustomed to. So the earthquake affects all those of weak nerves, or that have nervous complaints ; obnoxious to hysterics, colics, rheumatick pains in their joints ; several women were seized with violent head-achs, before both the shocks we felt in *London*. It was this that gave the people a shortness of breath. Mr. *Smith* from *Peterborough* speaks of a person that found himself very sick upon it. This made the dog run whining about the room, seeking to get out : this made the fishes leap up in the pond at *Southwark* ; like as the experiment of electrifying the fishes : it makes them sick. And this causes the birds in cages to hide their heads under their wings, because they cannot fly away. Which is commonly observ'd of them in *Italy*, and countries, where earthquakes are more frequent.

11ly, I observe, the shepherd at *Kensington* thought the motion of the earthquake, and the sound, was from the north-west to south-east ; the like Mr. *W. Smith* from *Peterborough*. On the contrary, Mr. *Byfield* the scarlet dyer in *Southwark*, thought the noise came from the river below bridge, and went toward *Westminster* ; where it rattled so, that he did not doubt, but that the abbey-church was beaten down.

Dr. *Parsons* took pains to find out the way of the motion of the earthquake, from the different position of people's beds ; but from the contradictory

dictory answers given, he cou'd not obtain any satisfaction, as to that point. All this, and what was observ'd from *Northampton*, of the motion being thought by some, to be upward and downward ; by others rather horizontal, or lateral : the counting the pulses, and the like, only points out to us the prodigious celerity, and the vibratory species of the motion of an earthquake. But far, very far is this from being owing to the tumultuous ebullition, the irregular hurry of subterraneous explosions.

12ly, How the atmosphere, and earth, are put into that electric and vibratory state, which prepares them to give, or receive the snap, and the shock, which we call an earthquake ; what it is, that immediately produces it, we cannot say : any more than we can define, what is the cause of magnetism, or of gravitation ; or how muscular motion is perform'd, or a thousand other secrets in nature.

We seem to know, that the author of the world has disseminated ethereal fire, thro' all matter, by which these great operations are brought about. This is the subtil fluid of Sir *Isaac Newton*, pervading all things : the occult fire diffused thro' the universe, according to *Marsilius Ficinus* the platonic philosopher, on the *Timeus* of his master. All the Platonists insist on an occult fire passing thro', and agitating all substance, by its vigorous and expansive motion.

Before

Before them, *Hippocrates* writes in the same sense, *I. de viētūs ratione*, that this fire moves all in all. This ethereal fire is one of the four elements of the ancients. It lies latent, and dispersed thro' all the other three, and quiescent : till collected into a quantity, that over-balances the circumjacent ; like the air crouded into a tempest : or till it is excited, by any proper motion.

This fire gives elasticity : and elasticity or vibration is the mother of electricity. We don't so much wonder at phosphorus arising from animal substances ; for this fire is in water, and betrays itself to our senses, in salt water. Many a time when I have pass'd the *Lincolnshire washes*, in the night time ; the horse has seem'd to tread in liquid flames. The same appearance is oft at the keel of a ship. Fire exists in water, says *Pliny*, as well as in human bodies. *nat. hist. II. 107.* Loaf sugar beaten in the dark is luminous. Many vegetables, as indian cane, and rotten wood the like, as *Bartholin* largely recites, *de luce hominum c. 4.* All electric bodies have this privilege : that is, they more easily discover it. Amber, gum lac, naptha, bitumens, some precious stones. My old friend Mr. *Stephen Gray* the father and great propagator of electricity, show'd me experiments therein, in the year 1705, then at *Corpus Christi* college in *Cambridge*. Afterward in the year 1719, he show'd by experiments

ments before the Royal Society, that paper, ribbands, silk, fatten, cloth, shavings, linen, goldbeaters skin, and in short, almost all kind of substances discover electrical sparks of fire in the dark : especially when well warm'd before the fire, or in a cold, dry, nitrous air, and in a room where there is no company. This same quality is found *in vacuo*, as Dr. *Desaguliers* show'd before the Royal Society, *march 31, 1720*. He took an exhausted glass globe, and caused it to be turn'd round violently, in an engine: by rubbing the hand upon it, it was illuminated within side, with purple streams. This gave foreigners the idea of using a glass globe, in electrical experiments.

The operation of the ethereal fire is various, nay, infinite, according to its quantity, and degree of incitement, progress, hindrance, or furtherance. One degree keeps water fluid, says the learned bishop of *Cloyne*: another turns it into elastic air, and air itself seems nothing else, but vapors, and exhalations render'd elastic, by this fire.

This same fire permeates, and dwells in all bodies; even diamond, flint, and steel. Its particles attract with the greatest force, when approximated. Again, when united, they fly asunder, with the greatest force, and celerity; it resists nothing quiescent, but when put into motion, it disdains all resistance. All this is according to the laws prescrib'd by the sovereign architect.

architect. This is the life, and soul of action, and reaction, in the universe. Thus has the great author provided against the native sluggishness of matter ! light, or fire in animals, is what we call the animal spirits ; and is the author of life, and motion. But we know not the immediate mode of muscular motion ; any more than how, in inanimate matter, it causes the vibrations of an earthquake.

Of this fire, the excellent *Manilius* thus writes, who liv'd in the time of *Augustus*.

Astronom. I.

*Sunt autem cunctis permisti partibus ignes ;
Qui gravidas habitant fabricantes fulmina nubes :
Et penetrant terras, Ætnamq; imitantur Olympo :
Et calidas reddunt ipsis in fontibus undas.
Ac silice in duro, viridiq; in cortice sedem
Inveniunt ; cum silva sibi collisa crematur.
Ignibus usq; adeo natura est omnis abundans !*

Which may thus be english'd.
Fire universal nature traverses.

It makes the thunderbolt in tumid clouds :
In dire Vulcano's penetrates the earth :
And fends the boiling water from its springs.
In hardest flint, and softest wood it dwells :
Which by collision shows itself in flame.
With fire so pregnant is all nature found !

13ly, The great question then with us, is how the surface of the earth is put into that vibratory

vibratory and electric state, by heat and dryness? we must needs acquit the internal of the earth from the charge of these superficial concussions. How then is the ethereal fire crowded together, or excited, so as to cause them; seeing in our ordinary electrical experiments, we make use of friction?

But that friction alone does not excite electricity, we know from the obvious experiment of flint and steel, where the suddenness of the stroke, and hardness of the matter does it. Another method of exciting it, is the letting off a number of great guns, which so crowds the ethereal fire together, as to electrify glass windows; observ'd by my friend the reverend Dr. Stephen Hales. The *aurora borealis*, *australis*, all kind of coruscations, meteors, lightning, thunder, fire-balls are the effects, and may reciprocally be the cause of electricity; but how in particular we know not. Come we to the animal world, we must needs assert, that all motion voluntary, involuntary, generation, even life itself: all the operations of the vegetable kingdom, and an infinity more of nature's works, are owing to the activity of this electric fire, the very soul of the material world. And in my opinion, 'tis this alone, that solves the famous question, so much agitated with the writers in medicin, about the heat of the blood. How these, how earthquakes are begun, propagated, we are yet to seek.

We

We may readily enough presume, that the contact between the electric, and the non-electric, which gives the snap, and the shock, must come from without, from the atmosphere. Perhaps by some meteor that crowds the ethereal fire together: which then flies off with that immense force that causes the earthquake. In the point of contact on the earth's surface, the same thing is done, perhaps, another time, by a shower of rain. Our thoughts upon this matter must needs be as immature, as they are novel. But we may readily conclude, that tho' the original stroke comes from the atmosphere, yet the atmosphere has no further concern in it: no aereal power, or change therein, can propagate itself so instantaneously, over so vast a surface, as 4000 miles square. Therefore the impetuous rushing noise in the air, accompanying the shock, is the effect, and not the cause. And all this is strongly confirm'd by this observation, that the barometer and thermometer receiv'd no change upon the earthquakes.

But surely, there is not a heart of flesh that is not affected with so stupendous a concussion! let a man estimate his own power, with that which causes an earthquake; and he will be persuaded, that somewhat more than ordinary is intended by so rare and wonderful a motion. That great genius *Hippocrates*, makes the whole of the animal œconomy to be administered,

stred, by what we call nature. And nature alone, says he, suffices for all things, to animals: she *knows* herself, and what is necessary for them. We must extend this thought to the inanimate world. And can we deny then, that he here means a conscious and intelligent nature, that presides over, and directs all things, moves the ethereal spirit or fire, that moves all things: a divine necessity, but a voluntary agent, who gives the commanding nod, to what we commonly call nature; the chief instrument in the most important operations of the vast machine, as well as in the ordinary ones, particularly the human one: administering the whole œconomy (as he says) without noise, unseen, unfelt. And this leads us,

14ly, Lastly, in regard to the spiritual use we ought to make of these extraordinary *pbænomena*, or of our inquiries about them, I shall first observe, that we find abroad, several of these earthquakes this year have been very fatal. In the last we read of, at *Philippopolis* in *Thrace*, the whole city was destroyed, above 4000 inhabitants killed. At home, where above half a score separate concussions have been felt, there has not been one house thrown down, one life lost. This ought to inspire us with a very serious reflection about them; nor is it altogether unworthy of our remark, that they began with us in *London*, in *February* last: and after visiting the circle of the globe, at present, end with us.

2dly,

2dly, We may observe, that if we did but read the works of *Hippocrates*, *Plato* and his followers; of *Tully*, *Galen*, and the like ethic writers of antiquity; whilst we study, and try the affections of matter; we should improve in philosophy, properly speaking: we should lift up our minds from these earthly wonders, and discern the celestial admonitions, they present to us.

The original meaning of the word philosophy, was rightly apply'd to moral wisdom. We who have advanc'd both the natural, and moral, should, as the ancients did, join them both together. By this means, we gather, the truth of the highest, and most excellent philosophy, to be found in those volumes of first antiquity, which we call sacred: and which, 'tis our peculiar, and inestimable happiness to possess. We should adore that divine light, which they hold forth to us. Especially in a country, where the principles of true religion are open, and undisguised: where the establish'd profession of it is rational, noble and lovely: worthy of the moral governor of the world; fit for him to enjoin: for us to practise, with pleasure and effect.

November 7, 1750.

W. STUKELEY.

Read at the Royal Society, *December 6.*

F I N I S.

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